

Claims

- [c1] 1. A method for heating a battery in a hybrid electric vehicle, the hybrid electric vehicle having an engine, a battery, a motor-generator powered by the engine or the battery and adapted to drive a vehicle wheel, and a control module for monitoring and controlling the hybrid electric vehicle, the method comprising the steps of: determining if a temperature of the battery is below a predetermined value;
determining whether a triggering event has occurred;
and
reversing polarity of a battery current if the temperature of the battery is below the predetermined value and a triggering event has occurred.
- [c2] 2. The method of claim 1 wherein the step of determining whether a triggering event has occurred includes determining whether a tip-in event, a tip-out event, or a terminal voltage event has occurred.
- [c3] 3. The method of claim 2 wherein determining whether a tip-in event has occurred comprises measuring a battery voltage and not reversing the polarity of the battery current if the battery voltage is low.

- [c4] 4. The method of claim 2 wherein determining whether a tip-out event has occurred comprising measuring a battery voltage and not reversing the polarity of the battery current if the battery voltage is high.
- [c5] 5. The method of claim 1 wherein reversing the polarity of the battery occurs at a first slew rate for the tip-in event and the tip-out event, and a second slew rate for the terminal voltage event.
- [c6] 6. The method of claim 5 wherein the first slew rate is faster than the second slew rate.
- [c7] 7. The method of claim 1 wherein the step of determining the temperature of the battery comprises comparing the predetermined value to a measured value from a battery temperature sensor.
- [c8] 8. The method of claim 2 wherein determining whether a tip-in event has occurred is based on a change in position of a gas pedal position sensor.
- [c9] 9. The method of claim 2 wherein determining whether a tip-out event has occurred is based on the change in position of a brake pedal position sensor or the gas pedal position sensor.
- [c10] 10. The method of claim 2 wherein the step of determin-

ing whether a terminal voltage event has occurred comprises comparing a terminal voltage value to a limit value that is indicative of the polarization resistance voltage of the battery.

- [c11] 11. A method for heating a battery in a hybrid electric vehicle, the hybrid electric vehicle having an engine, a battery, a motor-generator powered by the engine or the battery and adapted to drive a vehicle wheel, and a control module for monitoring and controlling the hybrid electric vehicle, the method comprising the steps of: determining if a temperature of the battery is below a predetermined value;
determining whether a previous polarity reversal has been completed;
determining whether a tip-in event has occurred;
determining whether a tip-out event has occurred;
determining whether a terminal voltage event has occurred; and
reversing polarity of a battery current if the temperature of the battery is below the predetermined value and the previous polarity reversal has been completed and a tip-in event, tip-out event, or a terminal voltage event has occurred.
- [c12] 12. The method of claim 11 wherein reversing the polarity of the battery current occurs at a first slew rate for

the tip-in event and the tip-out event, and a second slew rate for the terminal voltage event.

- [c13] 13. The method of claim 11 wherein the step of determining whether a previous polarity reversal has been completed further comprises determining whether the battery is charging or discharging after determining whether the previous polarity reversal has been completed.
- [c14] 14. The method of claim 12 wherein the step of determining whether a terminal voltage event has occurred further comprises comparing a measured terminal voltage value to a limit value that is indicative of the polarization resistance voltage of the battery.
- [c15] 15. The method of claim 14 wherein the step of determining whether a terminal voltage event has occurred further comprises determining whether the terminal voltage value is greater than a first limit value if the battery is discharging.
- [c16] 16. The method of claim 14 wherein the step of determining whether a terminal voltage event has occurred further comprises determining whether the terminal voltage value is less than a second limit value if the battery is charging.

- [c17] 17. The method of claim 11 wherein the step of reversing the polarity of the battery further comprises calculating a power target level and reversing the polarity of the battery current to the power target level.
- [c18] 18. The method of claim 11 wherein the step of determining whether a tip-in event has occurred is based on a change in position of a gas pedal position sensor.
- [c19] 19. The method of claim 11 wherein the step of determining whether a tip-out event has occurred is based on a change in position of a brake pedal position sensor or the gas pedal position sensor.
- [c20] 20. A method for heating a battery in a hybrid electric vehicle, the hybrid electric vehicle having an engine, a battery, a motor-generator powered by the engine or the battery and adapted to drive a vehicle wheel, and a control module for monitoring and controlling the hybrid electric vehicle, the method comprising the steps of: determining if a temperature of the battery is below a predetermined value;
determining whether a previous polarity reversal has been completed and preventing a subsequent polarity reversal from being implemented until the previous polarity reversal has been completed;

determining whether the battery is charging or discharging;

determining whether a terminal voltage event has occurred and reversing polarity of a battery current at a first slew rate if the terminal voltage event has occurred;

determining whether a tip-in event has occurred and reversing the polarity of the battery current at a second slew rate if the tip-in event has occurred; and

determining whether a tip-out event has occurred and reversing the polarity of the battery current at a second slew rate if the tip-out event has occurred.